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**METHOD, APPARATUS, AND PROGRAM FOR MAGNIFYING THE TEXT OF
A LINK WHILE STILL RETAINING BROWSER FUNCTION IN THE
MAGNIFIED DISPLAY**

5 **BACKGROUND OF THE INVENTION**

1. Technical Field:

The present invention relates to an improved data processing system and, in particular, to a method and
10 apparatus for managing world wide web documents in a data processing system. Still more particularly, the present invention provides a method, apparatus, and program for magnifying the text of a link while retaining browser functionality in the magnified display.

15

2. Description of Related Art:

The worldwide network of computers commonly known as the "Internet" has seen explosive growth in the last several years. Mainly, this growth has been fueled by
20 the introduction and widespread use of so-called "web browsers," which enable simple graphical user interface-based access to network servers, which support documents formatted as so-called "web pages." These web pages are versatile and customized by authors. For
25 example, web pages may mix text and graphic images. A web page also may include fonts of varying sizes.

A browser is a program that is executed on a graphical user interface (GUI). The browser allows a user to seamlessly load documents from the Internet and
30 display them by means of the GUI. These documents are commonly formatted using markup language protocols, such as hypertext markup language (HTML). Portions of text and images within a document are delimited by indicators,

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which affect the format for display. In HTML documents, the indicators are referred to as tags. Tags may include links, also referred to as "hyperlinks," to other pages. The browser gives some means of viewing the contents of web pages (or nodes) and of navigating from one web page to another in response to selection of the links.

The versatility and customization of web pages, however, are sometimes an impediment to users. Some web pages may be designed with small fonts to accommodate more content. For example, a "portal" may be designed to provide access to information and services, such as news, shopping, and stock quotes, from a wide variety of sources. This results in a very "busy" page with small fonts and many links to navigate.

Visually impaired users may find it difficult to locate links in documents with small print. Other users may have difficulty with fine motor movements and cannot manipulate a mouse pointer with accuracy, thus making it difficult to select links in a crowded portion of the page. Magnifiers exist that allow a user to select a portion of a web page and generate a magnified display of that portion. However, after a link is located in the magnified display, the user must return to the browser to locate and select the link. Therefore, a user with visual impairment or difficulty with fine motor movements still faces the problem of locating and selecting the link in the original display.

Thus, it would be advantageous to provide a magnified display while retaining the functionality of the web browser.

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SUMMARY OF THE INVENTION

The present invention provides a web browser that magnifies the content of the whole page in memory and
5 displays the relevant portion in a magnifier with hyperlinks. The web browser then maps the magnified display to the original document. Thus, manipulation of the mouse in the magnified display may result in an action with respect to the original document. For
10 example, the user may select a portion of text to be copied and pasted into another application. The user may also select a link for navigation within the magnified display. Alternatively, the web browser may analyze the original web page and construct magnifier contents on the
15 basis of either the document object model, extensible markup language (XML), or hypertext markup language (HTML) representation of the magnified portion.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1 depicts a pictorial representation of a network of data processing systems in which the present invention may be implemented;

Figure 2 is a block diagram of a data processing system that may be implemented as a server in accordance with a preferred embodiment of the present invention;

Figure 3 is a block diagram illustrating a data processing system in which the present invention may be implemented;

Figure 4 is an example of a screen of display of a browser window in accordance with a preferred embodiment of the present invention;

Figure 5 is an example screen of display of a browser window with a magnifier in accordance with a preferred embodiment of the present invention;

Figure 6 is a block diagram of a browser program in accordance with a preferred embodiment of the present invention;

Figure 7 is a block diagram of a memory configuration for a browser with a magnifier in accordance with a preferred embodiment of the present invention;

Figure 8 is an example document object model for a

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document with a magnified portion in accordance with a preferred embodiment of the present invention;

5 **Figure 9** is a flowchart illustrating the operation of a web browser that maps a magnified display to the original document in accordance with a preferred embodiment of the present invention; and

10 **Figure 10** is a flowchart illustrating the operation of a web browser that generates a magnified display using the document object model of the original document in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now to the figures, **Figure 1** depicts a pictorial representation of a network of data processing systems in which the present invention may be implemented. Network data processing system **100** is a network of computers in which the present invention may be implemented. Network data processing system **100** contains a network **102**, which is the medium used to provide communications links between various devices and computers connected together within network data processing system **100**. Network **102** may include connections, such as wire, wireless communication links, or fiber optic cables.

In the depicted example, a server **104** is connected to network **102** along with storage unit **106**. In addition, clients **108**, **110**, and **112** also are connected to network **102**. These clients **108**, **110**, and **112** may be, for example, personal computers or network computers. In the depicted example, server **104** provides data, such as boot files, operating system images, and applications to clients **108-112**. Clients **108**, **110**, and **112** are clients to server **104**. Network data processing system **100** may include additional servers, clients, and other devices not shown. In the depicted example, network data processing system **100** is the Internet with network **102** representing a worldwide collection of networks and gateways that use the TCP/IP suite of protocols to communicate with one another. At the heart of the Internet is a backbone of high-speed data communication lines between major nodes or host computers, consisting of thousands of commercial, government, educational and other computer systems that route data and messages. Of course, network data

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processing system 100 also may be implemented as a number of different types of networks, such as for example, an intranet, a local area network (LAN), or a wide area network (WAN). **Figure 1** is intended as an example, and not as an architectural limitation for the present invention.

Referring to **Figure 2**, a block diagram of a data processing system that may be implemented as a server, such as server 104 in **Figure 1**, is depicted in accordance with a preferred embodiment of the present invention.

Data processing system 200 may be a symmetric multiprocessor (SMP) system including a plurality of processors 202 and 204 connected to system bus 206. Alternatively, a single processor system may be employed. Also connected to system bus 206 is memory controller/cache 208, which provides an interface to local memory 209. I/O bus bridge 210 is connected to system bus 206 and provides an interface to I/O bus 212. Memory controller/cache 208 and I/O bus bridge 210 may be integrated as depicted.

Peripheral component interconnect (PCI) bus bridge 214 connected to I/O bus 212 provides an interface to PCI local bus 216. A number of modems may be connected to PCI bus 216. Typical PCI bus implementations will support four PCI expansion slots or add-in connectors.

Communications links to network computers 108-112 in **Figure 1** may be provided through modem 218 and network adapter 220 connected to PCI local bus 216 through add-in boards.

Additional PCI bus bridges 222 and 224 provide interfaces for additional PCI buses 226 and 228, from which additional modems or network adapters may be supported. In this manner, data processing system 200

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allows connections to multiple network computers. A memory-mapped graphics adapter **230** and hard disk **232** may also be connected to I/O bus **212** as depicted, either directly or indirectly.

5 Those of ordinary skill in the art will appreciate that the hardware depicted in **Figure 2** may vary. For example, other peripheral devices, such as optical disk drives and the like, also may be used in addition to or in place of the hardware depicted. The depicted example is
10 not meant to imply architectural limitations with respect to the present invention.

The data processing system depicted in **Figure 2** may be, for example, an IBM RISC/System 6000 system, a product of International Business Machines Corporation in Armonk,
15 New York, running the Advanced Interactive Executive (AIX) operating system.

With reference now to **Figure 3**, a block diagram illustrating a data processing system is depicted in which the present invention may be implemented. Data processing
20 system **300** is an example of a client computer. Data processing system **300** employs a peripheral component interconnect (PCI) local bus architecture. Although the depicted example employs a PCI bus, other bus architectures such as Accelerated Graphics Port (AGP) and
25 Industry Standard Architecture (ISA) may be used. Processor **302** and main memory **304** are connected to PCI local bus **306** through PCI bridge **308**. PCI bridge **308** also may include an integrated memory controller and cache memory for processor **302**. Additional connections to PCI
30 local bus **306** may be made through direct component interconnection or through add-in boards. In the depicted example, local area network (LAN) adapter **310**, SCSI host

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bus adapter **312**, and expansion bus interface **314** are connected to PCI local bus **306** by direct component connection. In contrast, audio adapter **316**, graphics adapter **318**, and audio/video adapter **319** are connected to
5 PCI local bus **306** by add-in boards inserted into expansion slots. Expansion bus interface **314** provides a connection for a keyboard and mouse adapter **320**, modem **322**, and additional memory **324**. Small computer system interface (SCSI) host bus adapter **312** provides a connection for hard
10 disk drive **326**, tape drive **328**, and CD-ROM drive **330**. Typical PCI local bus implementations will support three or four PCI expansion slots or add-in connectors.

An operating system runs on processor **302** and is used to coordinate and provide control of various components
15 within data processing system **300** in **Figure 3**. The operating system may be a commercially available operating system, such as Windows 2000, which is available from Microsoft Corporation. An object oriented programming system such as Java may run in conjunction with the
20 operating system and provide calls to the operating system from Java programs or applications executing on data processing system **300**. "Java" is a trademark of Sun Microsystems, Inc. Instructions for the operating system, the object-oriented operating system, and applications or
25 programs are located on storage devices, such as hard disk drive **326**, and may be loaded into main memory **304** for execution by processor **302**.

Those of ordinary skill in the art will appreciate that the hardware in **Figure 3** may vary depending on the
30 implementation. Other internal hardware or peripheral devices, such as flash ROM (or equivalent nonvolatile memory) or optical disk drives and the like, may be used

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in addition to or in place of the hardware depicted in **Figure 3**. Also, the processes of the present invention may be applied to a multiprocessor data processing system.

5 As another example, data processing system **300** may be a stand-alone system configured to be bootable without relying on some type of network communication interface, whether or not data processing system **300** comprises some type of network communication interface. As a further
10 example, data processing system **300** may be a Personal Digital Assistant (PDA) device, which is configured with ROM and/or flash ROM in order to provide non-volatile memory for storing operating system files and/or user-generated data.

15 The depicted example in **Figure 3** and above-described examples are not meant to imply architectural limitations. For example, data processing system **300** also may be a notebook computer or hand held computer in addition to taking the form of a PDA. Data processing
20 system **300** also may be a kiosk or a Web appliance.

 In accordance with a preferred embodiment of the present invention a web browser running on a client, such as clients **108, 110, 112** in **Figure 1** magnifies the content of the whole page in memory and displays the
25 relevant portion in a magnifier with hyperlinks. The web browser then maps the magnified display to the display space of the original document. Thus, manipulation of the mouse in the magnified display may result in an action with respect to the original document. For
30 example, the user may select a portion of text to be copied and pasted into another application. The user may also select a link for navigation within the magnified

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display. Alternatively, the web browser may analyze the original web page and construct magnifier contents on the basis of either the document object model, extensible markup language (XML), or hypertext markup language (HTML) representation of the magnified portion.

An example of a screen of display of a browser window is shown in **Figure 4** in accordance with a preferred embodiment of the present invention. The screen comprises window **400**, including a title bar **402**, which may display the name of the application program. Title bar **402** also includes a control box **404**, which produces a drop-down menu (not shown) when selected with the mouse, and "minimize" **406**, "maximize" or "restore" **408**, and "close" **410** buttons. The "minimize" and "maximize" or "restore" buttons **406** and **408** determine the manner in which the program window is displayed. In this example, the "close" button **410** produces an "exit" command when selected. The drop-down menu produced by selecting control box **404** includes commands corresponding to "minimize," "maximize" or "restore," and "close" buttons, as well as "move" and "resize" commands.

Browser window **400** also includes a menu bar **412**. Menus to be selected from menu bar **412** may include "File," "Edit," "View," "Insert," "Format," "Tools," "Window," and "Help." However, menu bar **412** may include fewer or more menus, as understood by a person of ordinary skill in the art. The browser window also includes toolbar **414** with buttons used to navigate web pages. The buttons may include, but are not limited to, "Back," "Forward," "Stop," "Refresh," "Home," and "Print."

The browser window includes a display area **416** in

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which the contents of a document are displayed. The document may be retrieved from a server, such as server 104 in **Figure 1**. The document may also be retrieved from another location, such as a hard disk in the client computer. As seen in **Figure 4**, a web page may contain many links displayed in a small font. Typically, links are displayed with underlining; however, other mechanisms may be used to differentiate hyperlinks within a document. For example, links may be displayed in a preselected color or the mouse cursor may change when moved over a hyperlink. Clusters of small links may present problems for users with visual impairment or difficulty with fine motor movements.

With reference now to **Figure 5**, an example screen of display of a browser window with a magnifier is shown in accordance with a preferred embodiment of the present invention. The screen comprises window 500, including display area 516. The screen also includes a magnifier window 550 that provides a magnified display of a selected portion of the original document. In accordance with a preferred embodiment of the present invention, the magnifier window retains browser functionality for the magnified portion.

Turning next to **Figure 6**, a block diagram of a browser program is depicted in accordance with a preferred embodiment of the present invention. A browser is an application used to navigate or view information or data in a distributed database, such as the Internet or the World Wide Web.

In this example, browser 600 includes a user interface 602, which is a graphical user interface (GUI) that allows the user to interface or communicate with

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browser **600**. This interface provides for selection of various functions through menus **604** and allows for navigation through navigation **606**. For example, menu **604** may allow a user to perform various functions, such as
5 saving a file, opening a new window, displaying a history, and entering a URL. Navigation **606** allows for a user to navigate various pages and to select web sites for viewing. For example, navigation **606** may allow a user to see a previous page or a subsequent page relative
10 to the present page. Preferences may be set through preferences **608**.

In accordance with a preferred embodiment of the present invention, user interface **602** provides a magnified display through magnifier **650**. The magnifier
15 may be invoked through commands or menus, such as a right-click menu or menus **412** in **Figure 4**. Also, toolbar **414** in **Figure 4** may include a button that may be selected to invoke the magnifier.

Communications **610** is the mechanism with which
20 browser **600** receives documents and other resources from a network such as the Internet. Further, communications **610** is used to send or upload documents and resources onto a network. In the depicted example, communication **610** uses hypertext transfer protocol (HTTP). Other
25 protocols may be used depending on the implementation. Documents that are received by browser **600** are processed by language interpretation **612**, which includes an HTML unit **614** and a JavaScript unit **616**. Language interpretation **612** will process a document for
30 presentation on graphical display **618**. In particular, HTML statements are processed by HTML unit **614** for presentation while JavaScript statements are processed by

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JavaScript unit **616**.

Graphical display **618** includes layout unit **620**, rendering unit **622**, and window management **624**. These units are involved in presenting web pages to a user

5 based on results from language interpretation **612**.

Magnifier **650** communicates with graphical display **618** to render the magnified portion of the document in the magnified display.

Browser **600** is presented as an example of a browser
10 program in which the present invention may be embodied. Browser **600** is not meant to imply architectural limitations to the present invention. Presently available browsers may include additional functions not shown or may omit functions shown in browser **600**. A browser may
15 be any application that is used to search for and display content on a distributed data processing system. Browser **600** may be implemented using known browser applications, such as Netscape Navigator or Microsoft Internet Explorer. Netscape Navigator is available from Netscape
20 Communications Corporation while Microsoft Internet Explorer is available from Microsoft Corporation.

With reference now to **Figure 7**, a block diagram of a memory configuration for a browser with a magnifier is shown in accordance with a preferred embodiment of the
25 present invention. Web browser **710** displays a document and magnifier **712** provides a magnified display of a selected portion of the document. Memory **720** includes storage **722** for regular web browser and associated data representation and storage **724** for web browser display
30 memory. Magnifier **712** displays a selected portion **725** from display memory **724**.

Mapping **730** provides a map between the magnified

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display area and a corresponding display area for the original document. This magnified area may be generated as a "bit-blit" -- reading a small area from the video RAM pixel-by-pixel and repopulating the adjacent cells of the expanded field using whatever magnification factor is desired. For example, the magnifier may create an expanded field with a 1:4 factor, or 1 pixel repopulated to 4 pixels, for a 2X enlargement. Thus, the existing RAM may support the rendering of the magnified display and mapping 730 maps mouse events in the magnified display to the corresponding coordinates in the "normal" display space.

Mapping 730 may also provide an imagemap between the displayed portion in the magnifier with corresponding data in the original document from data representation 722. An imagemap is a single picture image that is logically separated into areas, each of which is used to select a different option or display a different message when clicked. Imagemaps are widely used on the Web to provide a navigation bar to link to other topics or pages on a site. In accordance with a preferred embodiment of the present invention, the magnified display is mapped to the original document to form an imagemap with areas used to select options corresponding to the original document.

In an alternative embodiment of the present invention, the web browser may analyze the original web page and construct magnifier contents on the basis of either the document object model (DOM), extensible markup language (XML), or hypertext markup language (HTML) representation of the magnified portion. DOM is a common application programming interface (API) for accessing HTML and XML documents from a Web browser. DOM was developed to formalize Dynamic HTML, which allows

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animation, interaction and dynamic updating of Web pages. DOM provides a language and platform-neutral object model for Web pages, but because it deals with document structures in general, DOM may also be used by any
5 application that accesses documents.

With reference to **Figure 8**, an example document object model for a document with a magnified portion is illustrated in accordance with a preferred embodiment of the present invention. Document object model **800**
10 comprises a tree structure of nodes representing the document. Each node has a number of attributes. For example, a node may be "text" and the attributes may be "fontsize," "fontcolor," and "textstring."

DOM **800** includes node **802** with subnodes **804** and **806**.
15 Nodes **802**, **804**, **806** may represent a magnified portion **810** of a document. When a portion of the document is selected for magnified display, the magnifier may be generated based on the corresponding portion of the DOM. For example, if node **806** is a "text" node and the
20 original attribute values are 12-point font, red, and text "News," the values may be adjusted to 24-point font, red, and text "News" for the magnified display. Thus, the magnified portion presents a portion of the tree structure and retains full browser functionality. The
25 DOM illustrated in **Figure 8** is exemplary and the present invention may be implemented in a variety of ways, as will be readily apparent to a person of ordinary skill in the art.

With reference to **Figure 9**, a flowchart illustrating
30 the operation of a web browser that maps a magnified display to the original document is shown in accordance with a preferred embodiment of the present invention.

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The process begins and a determination is made as to whether an exit condition exists (step 902). An exit condition may exist when a user closes the browser window or exits through a menu command. If an exit condition
5 exists, the process ends.

If an exit condition does not exist in step 902, a determination is made as to whether a portion is selected for magnification (step 904). If a portion is not selected for magnification, a determination is made as to
10 whether another action is requested through the user interface (step 906). If another action is requested, the process performs the other browser action (step 908) and returns to step 902 to determine whether an exit condition exists. An action in step 908 may be selection
15 of a link within the normal browser display, in which case the process retrieves and displays a new document. If another action is not requested in step 908, the process returns to step 902 to determine whether an exit condition exists.

Returning to step 904, if a portion of the document is selected for magnification, the process magnifies the selected portion from display memory (step 910) and maps the magnified portion to the original document content (step 912). Next, a determination is made as to whether
20 an action is requested within the magnifier interface (step 914). If an action is requested within the magnifier interface, a determination is made as to whether the action is a selection of a link (step 916). If a link is not selected, the process performs the
25 action with respect to the original document and returns to step 914 to determine whether an action is requested within the magnifier interface.
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If the action is the selection of a link in step 916, the process retrieves and displays the new document (step 920), closes the magnifier display (step 922), and returns to step 902 to determine whether an exit condition exists.

Returning to step 914, if an action is not requested in the magnifier interface, a determination is made as to whether a request to close the magnifier is received (step 924). If a request to close the magnifier is received, the process closes the magnifier (step 922) and returns to step 902 to determine whether an exit condition exists. If a request to close the magnifier is not received in step 924, the process returns to step 914 to determine whether an action is requested in the magnifier interface.

Turning now to **Figure 10**, a flowchart illustrating the operation of a web browser that generates a magnified display using the document object model of the original document is shown in accordance with a preferred embodiment of the present invention. The process begins and a determination is made as to whether an exit condition exists (step 1002). An exit condition may exist when a user closes the browser window or exits through a menu command. If an exit condition exists, the process ends.

If an exit condition does not exist in step 1002, a determination is made as to whether a portion is selected for magnification (step 1004). If a portion is not selected for magnification, a determination is made as to whether another action is requested through the user interface (step 1006). If another action is requested, the process performs the other browser action (step 1008)

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and returns to step 1002 to determine whether an exit condition exists. An action in step 1008 may be selection of a link within the normal browser display, in which case the process retrieves and displays a new document. If another action is not requested in step 1008, the process returns to step 1002 to determine whether an exit condition exists.

Returning to step 1004, if a portion of the document is selected for magnification, the process creates the magnified display using the document object model of the original document (step 1010). Next, a determination is made as to whether an action is requested within the magnifier interface (step 1012). If an action is requested within the magnifier interface, a determination is made as to whether the action is a selection of a link (step 1014). If a link is not selected, the process performs the action with respect to the original document and returns to step 1012 to determine whether an action is requested within the magnifier interface.

If the action is the selection of a link in step 1014, the process retrieves and displays the new document (step 1018), closes the magnifier display (step 1020), and returns to step 1002 to determine whether an exit condition exists.

Returning to step 1012, if an action is not requested in the magnifier interface, a determination is made as to whether a request to close the magnifier is received (step 1022). If a request to close the magnifier is received, the process closes the magnifier (step 1020) and returns to step 1002 to determine whether an exit condition exists. If a request to close the magnifier is not received in step 1022, the process

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returns to step 1012 to determine whether an action is requested in the magnifier interface.

Thus, the present invention solves the disadvantages of the prior art by providing a web browser that
5 magnifies the content of the whole page in memory and displays the relevant portion in a magnifier with hyperlinks. The web browser maps the magnified display to the original document. Thus, manipulation of the mouse in the magnified display may result in an action
10 with respect to the original document. The user may also select a link for navigation within the magnified display. Alternatively, the web browser may analyze the original web page and construct magnifier contents on the basis of either the document object model, XML, or HTML
15 representation of the magnified portion. Thus, the user need not repeatedly magnify the document and return to the original display to select links. Furthermore, changing font sizes within the entirety of the original display to enlarge text may adversely effect the layout
20 of the page. Using the present invention, the user may select links or perform other browser functions within the magnified display.

It is important to note that while the present invention has been described in the context of a fully
25 functioning data processing system, those of ordinary skill in the art will appreciate that the processes of the present invention are capable of being distributed in the form of a computer readable medium of instructions and a variety of forms and that the present invention
30 applies equally regardless of the particular type of signal bearing media actually used to carry out the distribution. Examples of computer readable media include recordable-type media, such as a floppy disk, a

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hard disk drive, a RAM, CD-ROMs, DVD-ROMs, and transmission-type media, such as digital and analog communications links, wired or wireless communications links using transmission forms, such as, for example, radio frequency and light wave transmissions. The computer readable media may take the form of coded formats that are decoded for actual use in a particular data processing system.

The description of the present invention has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. The embodiment was chosen and described in order to best explain the principles of the invention, the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.